20

Diesel Railway Traction

Transmissions

AN interesting paper by Mr. L. H. Pomeroy is published in the May issue of the Transactions of the Institution of Engineers and Shipbuilders in Scotland. Bearing the title "Automobile Transmission Systems," and copiously illustrated, it is a well-balanced résumé of what has been done to overcome the drawbacks of the ordinary friction clutch and clash type gearbox in automobiles. No one system of transmission is described to the detriment of the rest, though the author wisely dwells longest on that transmission with which he is most familiar —namely, the Daimler system incorporating the Wilson preselective epicyclic gearbox and a hydraulic coupling or fluid flywheel. Concerning this system, we are told, among other things, that the powerful gripping action of the low-speed brake band is difficult to control with finesse, so that a fierce "take-up" would be experienced under certain conditions but for the presence of the fluid coupling. We can readily believe that the fluid coupling affords the best all-round protection to any transmission with which it can be arranged to work, but we have observed that on the Drewry railcars no fierceness whatever is apparent in first speed with the Wilson gearbox, despite the absence of fluid couplings. In these cars the spring which tightens the bands round the various gear drums is compressed pneumatically, and its release is effected with perfect smoothness by letting the air out at a rate which is pre-determined and beyond the control of the driver. During the tests we witnessed, the loaded car, even on a rising grade of 1 in 100, could be started from rest in first and other low speeds, with the engines no more than idling.

The Great Western Railcars

BY the courtesy of the owners and builders, we have been able to follow during the last two or three months the various stages in the design and construction of the new A.E.C. railcars for the Great Western Railway, and we have had not only the privilege of attending the official trial runs but also of witnessing the test trips made with the chassis on the Southall-Brentford branch of the G.W.R. Many of the features incorporated in these vehicles differ widely from the accepted standards for railcar work, but a certain amount of experience has been gained with them on the first A.E.C. car, which has covered nearly 30,000 miles in the Thames valley since the beginning of February last, and has lost time on two occasions only.

In so far as the mechanical details are concerned, the most unusual point is the combination of a gear drive for one engine and direct drive for the other. The builders claim that this arrangement saves a certain amount of weight and cost, but with their further contention that it also results in less complication we are not inclined to agree, for a somewhat intricate compensating device is necessary to give only partial opening to the direct-drive throttle until such time as the other engine is working in top gear. Moreover, the railcar starts from rest on the geared engine only, and although the direct-drive unit comes into operation almost immediately, its effect is small by reason of the greatly restricted throttle opening. The car thus does not possess the accelerative capacity which its engine power might lead one to believe, although an examination of the speed curve reproduced on another page will show that the car is not deficient in this respect if judged by steam standards. The layout of the power units was determined by considerations of accessibility, and we have been much impressed by the ease and rapidity with which the engines and their auxiliaries can be uncovered and light adjustments or replacements made.

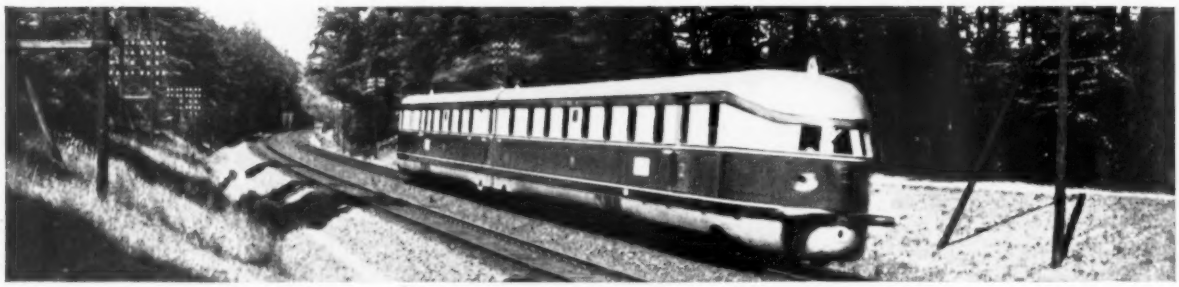
Viewing the car through the eyes of a passenger there are two defects which we think will be noticed. In the first place, to pass to the buffet, one must go through a short gangway in which the two swing doors are uncomfortably close to each other, and secondly, two lavatories open off this gangway. A better layout could be obtained by arranging the lavatories at the other end of the car, although this would add some complication to the layout of the water pipes and silencers. The ventilation of the car in hot weather is good, and the combination of Colt ventilators in the roof and Beresford extractors above the windows works most efficiently, but in future cars we would like to see drop lights in the centre doors. A good deal of weight must have been saved by the extensive use which has been made of aluminium for the body panels. We have recorded more than one example recently in which weight has been saved by the use of this material, but the present application is, we believe, unusual in that commercially pure aluminium has been used in preference to an aluminium alloy. The above remarks cover but a few of the many interesting details of the three vehicles which are now completed, but full particulars of the design and construction will be found in another part of this issue.

Egyptian Diesel Order

AN order for ten 200 b.h.p. standard gauge diesel railcars has just been placed by the Egyptian State Railways on terms which seem to indicate that the world is not yet solid in its belief in diesel traction, even when given favourable circumstances. Ganz & Co. Ltd., of Budapest, are the contractors, and we understand that should the first two cars prove unsuitable in any way, the contract for the remainder will be cancelled. The cars are to be of the double-bogie type, 72 ft. long, with a seating capacity of 71, and some of them are to be used on the new Cairo-Suez line. Special ventilating plant and cold water drinking fountains are to be provided, and the body construction will be of the all-steel streamlined type. The price per car is £E.7,585, but it is to be regretted that apparently various other considerations prevented the order going to a British firm.

RAILCARS OF THE REICHSBAHN—I

Over 300 diesel-engined railcars are in operation or under construction for passenger and goods services with maximum speeds varying from 40 to 100 m.p.h.



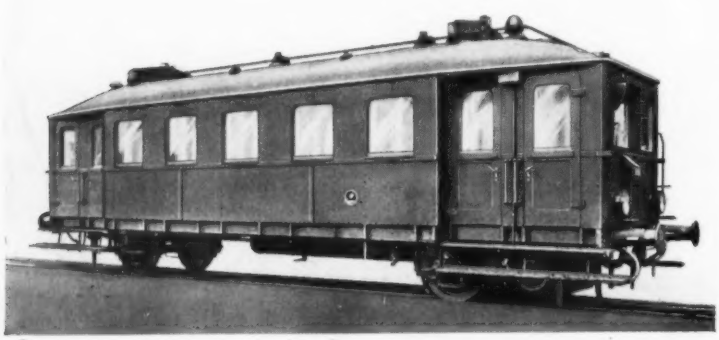
The Flying Hamburger at full speed in the Sachsenwald, near Friedrichsruh

THE German State Railway was one of the first big lines to give a trial to diesel traction, and its connection with railcars propelled by compression-ignition engines dates from 1924, when the first of the long line of 150 b.h.p. Maybach-engined vehicles was put into service. During 1924 and 1925, 18 of these cars, some of them arranged to carry parcels and light goods only, were introduced, and all of them are still at work, although now rated at 175 b.h.p. Several four-wheeled cars with 75 b.h.p. M.A.N. engines and mechanical transmission were introduced in 1925-27, and some of these have recently been rebuilt with lightweight engines of 150 b.h.p. by the same makers.

An extension of diesel railcar working was projected in 1930, the programme comprising light four-wheeled cars, low-powered double-bogie cars, high-powered double-bogie cars, and, as a *magnum opus*, the Flying Hamburger. The first class of car was powered by Daimler-Benz engines of 120 b.h.p. (since raised to 135 b.h.p.), and the two initial vehicles of this class were the first to embody the modern light steel body and frame construction. Other cars of a similar type, with 150 b.h.p. M.A.N. engines, made their appearance in 1932, but when further units by the same makers were built in 1933, gear drive was adopted in place of the electric transmission of the earlier vehicles.

For the second class of car, the old Maybach 150 b.h.p. air injection engine of 1924-25 was increased in output to 175 b.h.p., and fitted to cars of a similar outline to the original vehicles, but by adopting up-to-date construction the tare weight was brought down to 28·5 tons from the old figure of 36-40 tons. The third type of vehicle, viz., the high-powered double-bogie car, required something new in diesel engines, and to that end the Maybach Motorenbau developed its now famous 12-cylinder V-type engine developing 410 b.h.p. at 1,400 r.p.m. The first three cars of this type were set to work in 1931 and were fitted with the Lemp system of electrical control. They tared no less than 51 tons for a seating capacity of 72, and although intended for frequent work with trailers, the unit weight was obviously too high, and when three further cars were built in the following year, the empty weight was brought down to 41 tons. The same type of engine was used in the Flying Hamburger, the two power units of this vehicle producing a total of 820 b.h.p.

Experience proved that there were distinct possibilities for a railcar of appreciable power and having a maximum speed in the neighbourhood of 60 m.p.h. Three cars were ordered with 300 b.h.p. Motorenwerke Mannheim (MWM) engines and a further three with Daimler-Benz engines of the same output. The former class was described in this Supplement for October 6, 1933, and the latter in the issue for March 23, 1934. The order for the Daimler-Benz engined cars was subsequently increased to 11, and an order was also placed for seven cars with a new type of M.A.N. engine developing 300 b.h.p., all of which are not yet delivered. The main contractor in a number of cases was the Triebwagenbau A.G., and the majority of the mechanical portions were constructed at the works of Wumag (Gorlitz), EVA (Wismar), M.A.N. (Nürnberg), and Linke-Hoffmann (Breslau). The Lemp control has been given up in favour of the Gebus system. The cars of this type are used mainly for fast services over medium distances, such as in the Ruhr, where business trains are worked over the Cologne-Essen-Dortmund-Hagen-Wuppertal-Cologne circuit by a 410 b.h.p. diesel-electric railcar hauling one or two trailers, the end vehicle being a driving trailer.



An early type of 75 b.h.p. diesel-mechanical railcar

Big New Programme

Last year a greatly increased use for light low-powered cars was mapped out, and a number of orders placed for vehicles

of 135 to 150 b.h.p., but it was felt that a somewhat greater engine power would be advantageous and orders were placed for 44 cars with 210 b.h.p. Maybach engines. This new line of Maybach's was evolved by taking one cylinder bank from the 12-cylinder 410 b.h.p. engine and mounting it on a crankcase of normal design. The above orders were hardly placed before a complete programme was drawn up for the operation of long-distance services by diesel railcars at speeds far above anything which has yet been attempted in any country, except for isolated trains. The end to end speeds projected vary from 76·6 m.p.h. over the 211 miles from Berlin to Bremen, to 69·8 m.p.h. over the 419 miles from Berlin to Munich, and 55·1 m.p.h. over the more heavily-graded line from the German capital to Stuttgart via Erfurt.

As recently pointed out by Dr. Dorpmüller, General Manager of the Reichsbahn, some years must elapse before the full programme (covering services on 22 of the principal lines in Germany, with a route mileage of 5,800) can be inaugurated, but a start is to be made with the summer timetables of 1935. An unprecedented number of railcars will be necessary to work these services, and orders for well over 100 vehicles have already been placed, as may be seen from the accompanying table, which is drawn up from the official list of the Reichsbahn. In addition to 16 trains of the Flying Hamburger type, with electric transmission and an output of 820 b.h.p., there are also on order four triple-articulated trains in which the usual Maybach 410 b.h.p. engine will be supercharged

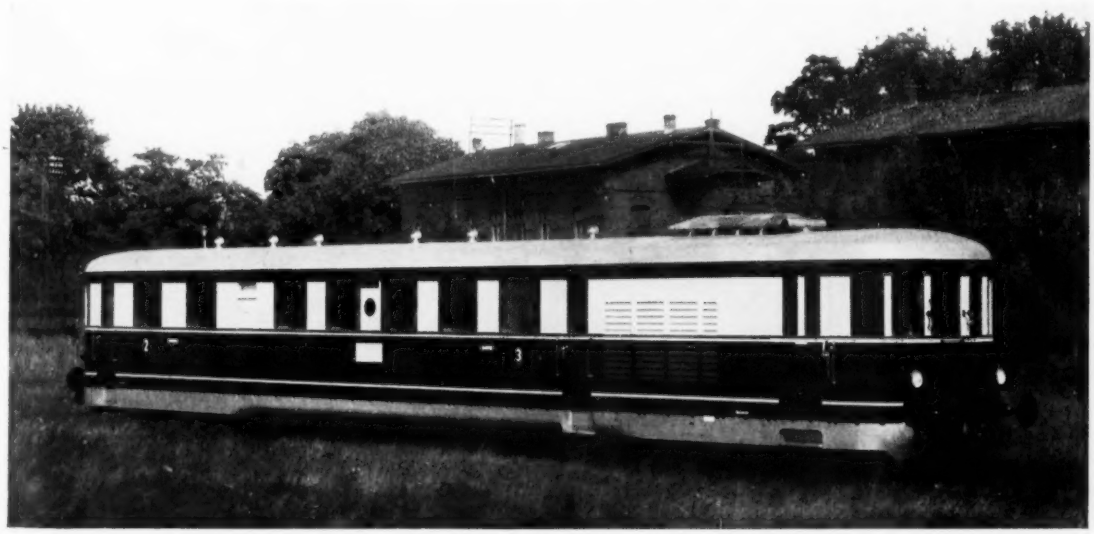
DIESEL RAILCARS ON THE GERMAN STATE RAILWAY

No. of Cars.	No. of Axles.	B.h.p.	Engine Make.	Transmission.	No. of Seats.	Max. Speed m.p.h.	Year Built.
18	4	150*	Maybach	Mech.	53–89	40	1924–25
4	2	75†	M.A.N.	,,	46	43	1925–27
3	4**	150††	,,	,,	83–87	43	1925–28
3	4	410	Maybach	Elec.	72	56	1931
2	2	120‡	Daimler§	,,	43	40	1931–32
10	2	150	M.A.N.	,,	45	43	1932
1	6	820††	Maybach	,,	102	100	1932
25	4	175	,,	Mech.	63	50	1932–33
3	4	410	,,	Elec.	72	62	1932
3	4	300	M.W.M.	,,	66	56	1933
10	2	135	Daimler§	Mech.	40	44	1933
16	2	150	M.A.N.	,,	40	44	1933
11	4	300	Daimler§	Elec.	66	56	1933–34
44	4	210	Maybach	Mech.	61	50	1933–34
125	4	410	,,	Elec.	61	69	1933–35
7	4	300	M.A.N.	,, ‡‡	66	62	1934
9	2	135	Daimler§	Mech.	40	43	1934
7	2	150	M.A.N.	,,	40	43	1934
3	2	210	Maybach	Hydraulic	61	43	1934
2	4	410	,,	,,	61	69	1934–35
4	4	600	?	Elec.	61	81	1934–35
13	6	820††	Maybach	,,	81	100	1934–35
1	8	820††	,,	,,	150	100	1935
4	8	1,200††	,,	,,	150	100	1935

* Now 175 b.h.p. † Now rebuilt with 150 b.h.p. engines. ** Two four-wheeled cars coupled permanently. †† Two engines. ‡ Now 135 b.h.p. ‡‡ Two cars with hydraulic drive. § Daimler-built engines are of Mercedes type.

non-stop at an average speed of approximately 73 m.p.h., Dr. Dorpmüller made some interesting remarks about high speed railcars and their future in Germany. Speaking to a representative of the German Nachrichtenbüro, he said that now the Flying Hamburger had demonstrated its utility in regular service for more than a year on the comparatively short line between Berlin and Hamburg, it was desired to show its capabilities over longer distances. The Berlin-Cologne line was chosen for this purpose in view of the real need for a rapid connection between the capital and the western trade centre. Also, this road being technically very suitable for the demonstration, it was possible to run for nearly two hours at the maximum speed of 160 km.p.h. (99·4 m.p.h.) between Wustermark (Brandenburg) and Hamm (Westphalia), after which the many curves in the line afforded the possibility of demonstrating the safety of the car when running over points and curves at speeds up to 100 km.p.h. (62·1 m.p.h.).

Operating experience with the Flying Hamburger in the

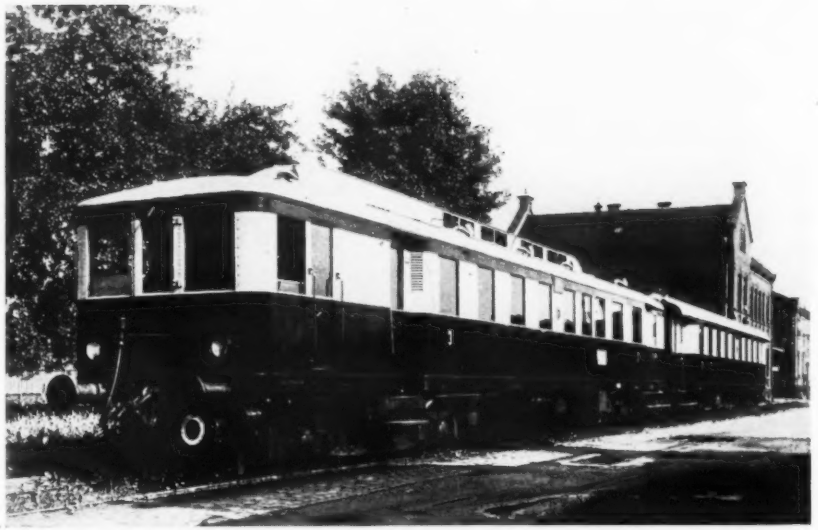


Double-bogie car with 300 b.h.p. 12-cylinder Daimler-Benz engine

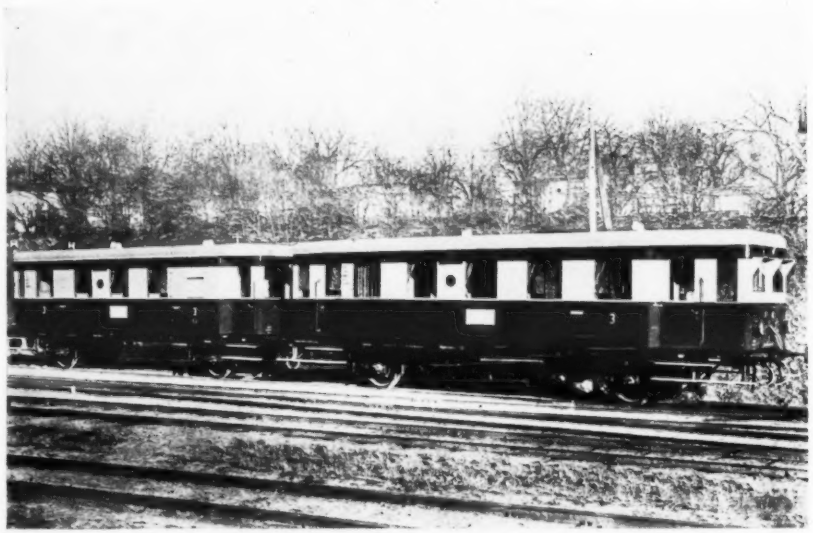
up to 600 b.h.p. (giving 1,200 b.h.p. per train), and it is reported that two of these trains will be fitted with Voith-Sinclair turbo-converters. The feature of the table, however, is the 125 cars with 410 b.h.p. Maybach engines and electric transmission.

The decision to adopt such services was made with a view to developing traffic between important centres, and the success which has attended the running of the Flying Hamburger indicated the direction in which successful operation might be expected. Several high-speed trials have recently been run between Berlin and Cologne with the above car, and at the conclusion of one of these, when the 357 miles between the two cities had been covered

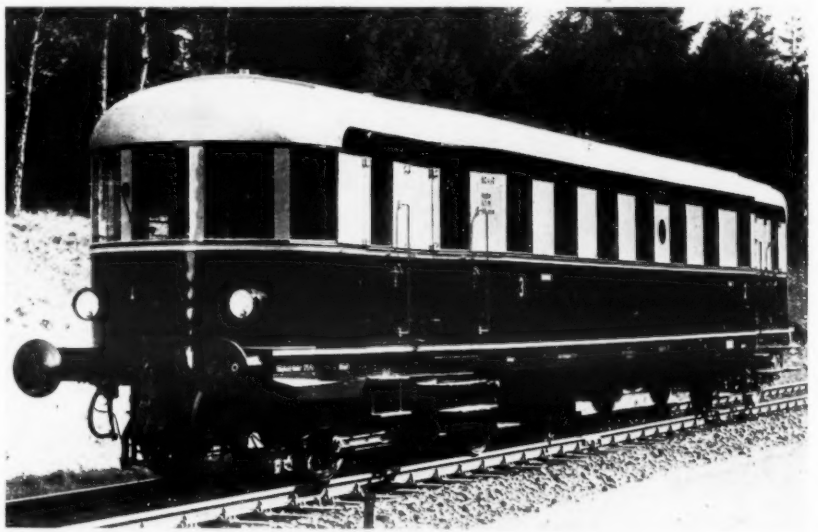
One of a batch of 150 b.h.p. Maybach diesel-mechanical railcars built for the Reichsbahn in 1924-25



A 410 b.h.p. diesel-electric railcar with Maybach 12-cylinder engine trailer, built in 1931



Light two-axle M.A.N.-engined diesel-electric railcar with four-wheeled third class trailer



A later type of low-powered Maybach railcar in which the engine output has been raised from 150 to 175 b.h.p.

Early 150 b.h.p. Maybach diesel railcar

Berlin-Hamburg service had been very satisfactory. In the course of 312 working days, the car was out of service for 38 days for repairs and modifications, which resulted in considerable improvements. After a century of experience with the steam locomotive it had still to be reckoned that for 100 working days, 22 days were required for overhaul and repair; hence the new construction might be considered particularly successful. Practical experience had shown that the high-speed railcar was as safe and serviceable as the latest locomotives. Improvements which had been introduced had completely eliminated the oscillations which were at first a source of discomfort to passengers, and the high-speed car was as steady running as the long-distance FD corridor express trains notwithstanding its higher speed. A glass full of water would stand on a table without spilling while the car was running.

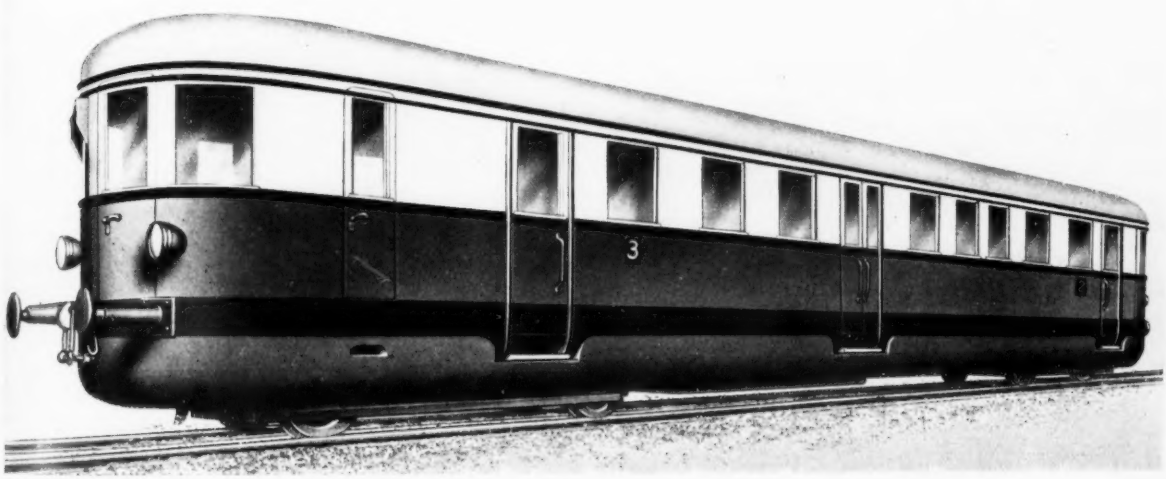
Asked whether special preparations in the way of track laying and new signalling arrangements had been necessary for the Berlin-Cologne trial run, Dr. Dorpmüller explained that a number of trials were conducted prior to the demonstration run on June 17. The requirements for high-speed running were known from the experience gained on the Berlin-Hamburg line, in accordance with which the distant signals had been moved from 700 m. ahead of stop signals to 1,000 m. therefrom (766 yd. to 1,094 yd.). The only special arrangement for the run on June 17 was the offering of the car two block sections ahead. During recent years the whole of the permanent way on the principal lines of the German State Railway had been completely renewed in accordance with the requirements of long-distance express traffic, and railcars of the Flying Hamburger type could be operated on these routes with few speed restrictions, and most of the latter could be eliminated at small cost.

Future Diesel Railcar Developments in Germany

As regards further developments in high-speed railcars, Dr. Dorpmüller stated that the two-coach Flying Hamburger by no means represented the last word. A new construction was on order, consisting of three coupled coaches with 600 b.h.p. (instead of 410 b.h.p.) diesel engines. Speeds exceeding 200 km.p.h. (124 m.p.h.) had been reached during the trials of 1903, and it was possible that they would be attained by new railcars, but it remained to be ascertained whether such speeds could be run with reliability in regular service.

No decision had yet been reached as to which lines should first be equipped with high-speed railcars, and Dr. Dorpmüller said on this point: "I shall be grateful if exaggerated expectations are not raised concerning the equipment of further lines. It must be some years before we have any considerable number of high-speed railcar services. Regular service on the Berlin-Cologne line is unlikely to be established before May 15, 1935, and the experience acquired will be applied to other lines."

(To be continued)



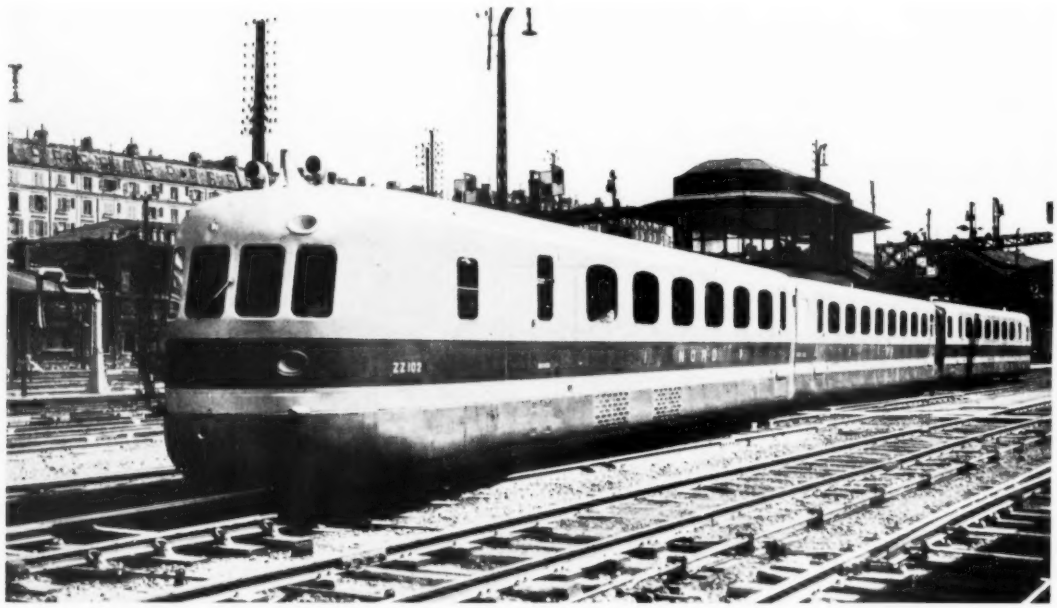
M.A.N. 300 b.h.p. double-bogie diesel-electric railcar on the Reichsbahn

A later type of low-powered Maybach railcar in which the engine output has been raised from 150 to 175 b.h.p.

Light two-axle M.A.N.-engined diesel-electric railcar with four-wheeled third class trailer

DIESEL-ELECTRIC EXPRESS ON THE NORD

Triple-car trains of welded construction maintain business services on the Paris-Lille route



The first of the new 820 b.h.p. Maybach-engined diesel-electric trains which are to maintain an express service between Paris, Lille, and Tourcoing, on the C. de fer du Nord

AS we recorded in our issue of April 21, 1933, the Northern Railway of France about 18 months ago placed an order for two streamlined diesel trains with the Société Franco-Belge, of Raismes. These trains have now been delivered, and by the kindness of M. Lancrenon, Ingénieur en Chef du Matériel et de la Traction of the Nord, we are able to describe them in detail.

According to the summer timetables, these trains will work on the duties for which they were specially designed, viz., a fast service in both directions between Paris and Tourcoing, via Lille. Leaving Tourcoing at 11.15 a.m., the train is due in Paris at 2.15 p.m., after making stops at Roubaix, Lille, Douai, Arras and Longeau. On the return journey, Paris is left at 4.25 p.m. and Tourcoing reached at 7.27 p.m., giving an end-to-end speed of 56 m.p.h. over the 168½ miles. The times are thus slightly faster than those of the best steam services, which are 3 hr. 12 min. in both directions, but the point-to-point timings are almost identical, the diesel train gaining by shorter stops. These runs are well within the speed capacity of the new units, which during the course of their trials have attained a maximum speed of 98¼ m.p.h. This makes the fourth type of diesel-train or car to attain a speed of 90 m.p.h. or over.

Embodying Maybach diesel engines and electric transmission, the new trains on the Nord may be viewed as an extension of the principles applied to the Flying Hamburger, but with the important difference that articulation has not been incorporated, the three vehicles making up the train being closely and permanently coupled together by Willison couplers. The end vehicles are self-contained motor coaches, and can thus be run alone or with a number of specially fitted trailers, as may be desired. First and second class accommodation is provided in each

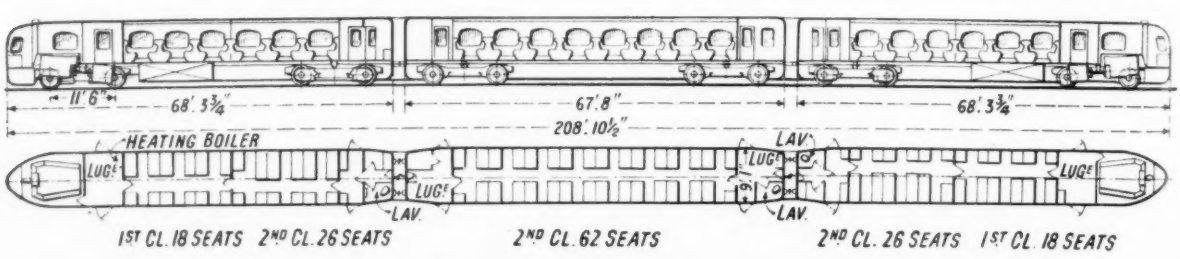
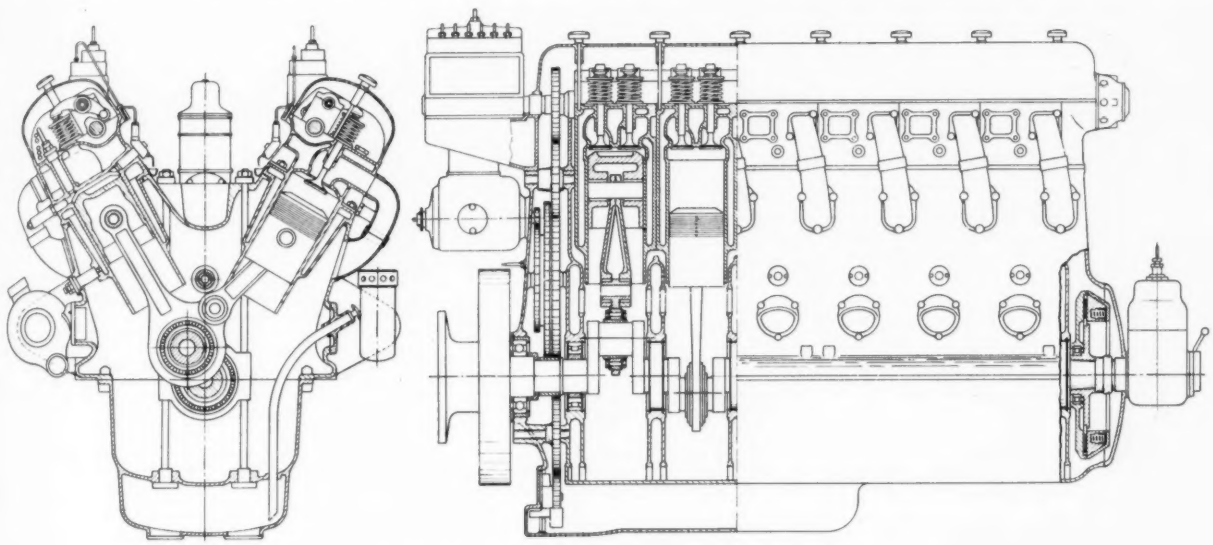


Diagram of the Nord streamlined diesel-electric express train

motor unit, and it is intended to fit up the two present three-car trains with a bar to be run by the International Sleeping Car Company.

Each of the two power units comprises a 12-cylinder V Maybach engine of 410 b.h.p. coupled by a short shaft with two flexible couplings to a 260-kW. direct current generator, and, as may be seen from the diagram accompanying this article, they are mounted directly on the outer bogies as on the Flying Hamburger. Spencer Moulton rubber springs are used in the suspension. The engines have cylinders of 5·91 in. bore and 7·9 in. stroke, and weigh approximately 10·5 lb. per b.h.p. At full load the fuel consumption is 0·41 lb. per b.h.p. hr., and the minimum normal fuel consumption of 0·378 lb. is reached at three-quarter load.

The transmission equipment includes four nose-suspended traction motors mounted on the inner bogies of the power cars. On the continuous rating, each motor has a capacity of 100 kW. at 725 volts, and 150 kW. at the same voltage on the one-hour rating; the two motors on each bogie are coupled permanently in parallel. The



Maybach 410 b.h.p high-speed diesel engine as used in the Nord trains

generators which supply the current to the motors have a continuous capacity of 260 kW. each, and an hourly rating of 310 kW., both values being at the normal engine speed of 1,400 r.p.m. Generators and motors are of the self-ventilated type, but the fans on the armature shaft draw in the air through ducts leading from the passenger compartments, the adequate ventilation of which is thus assured. The control is of the Gebus type, and the auxiliary drives and excitation of the main generator fields are effected by an auxiliary generator of 6 kW. capacity, which also charges the 48-cell 143 amp. hr. nickel-cadmium battery. This battery provides current for the auxiliaries when the engine is not running, and for the lighting system, and to the main generator for starting the engine.

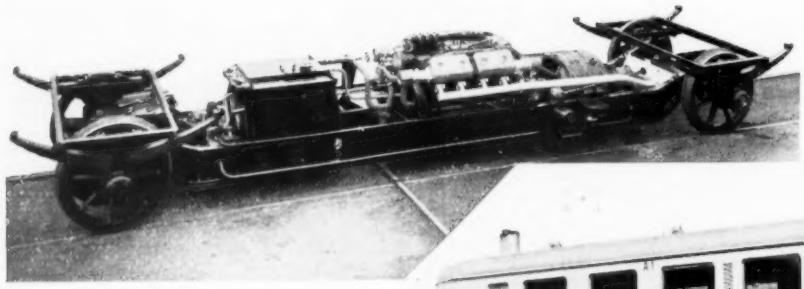
The power car underframes are constructed of steel, and are integral with the body, which is also made of steel so far as stressed members are concerned, the whole combination being welded-up. Two driving positions are provided in each power car, so that it may run in either direction when alone. There is seating accommodation for 18 first class and 26 second class passengers, and with the 62 second class seats in the trailer, a three-coach train has a total seating capacity of 150 on a tare weight of 122 tons, giving a ratio of 1,820 lb. per seat, and a b.h.p. per ton of 6·7. The seats, windows, and interior fittings generally are similar to those fitted in the latest Nord steel main-line carriages, and the lighting is on a 20-volt circuit, except for the headlights, which are run straight off the battery.

Between the engine and passenger compartments is a luggage room with a capacity of 1½ tons, which contains a hot water boiler for heating the train. The heating system is thermostatically controlled in a manner similar to that used in the Belgian diesel-electric train described in this Supplement for May 18. Lavatory accommodation is provided at the inner end, and the car is fitted with vestibules which are covered by a casing extending to the full width of the vehicle in order to reduce the effect of eddy currents at high speed.

The bogies are built up on frames of chrome-molybdenum steel, and both the motor bogie and that carrying the power equipment run on 38-in. wheels spread over the long base of 11 ft. 6 in. The nickel-chrome steel axles are carried in S.K.F. roller bearings, and braking is effected on the Jourdain-Monneret hydro-pneumatic system with the addition of an electro-magnetic brake for use in emergency. A hand brake is also fitted in each driving cabin, and acts on the wheels of the adjacent bogie only. Each railcar scales 43·8 tons tare, or approximately 49·5 tons in working order and with 44 passengers.

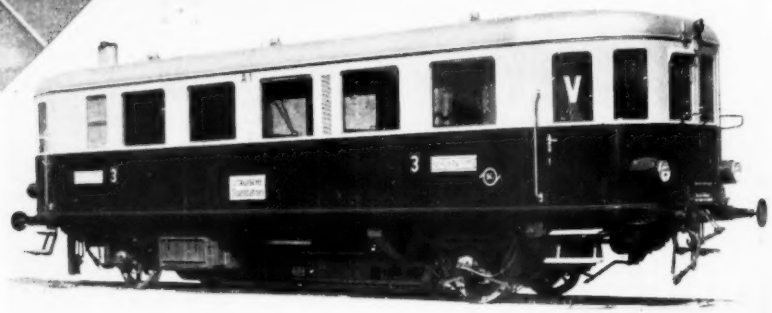
Trailer

Although slightly shorter than the power cars in overall length, the double-bogie trailer has a somewhat longer wheelbase owing to the greater pitch of the bogies, 46 ft. 8½ in. against 44 ft. 6 in., the bogie wheelbase being the same. The general construction of the welded body and underframe is the same as that of the power cars, to which the trailer is attached by means of modified Willison centre couplers. There is one long centre compartment seating 62 second class passengers, entrance to which is gained through small baggage compartments at each end. A lavatory is fitted in one of these compartments. The trailer has a tare weight of 34·4 tons, and is fitted with Jourdain-Monneret hydro-pneumatic brakes.



Left: Method of carrying power and transmission equipment on subframe

Below: 130 b.h.p. diesel-electric railcar for local traffic, Lithuanian State Railways



LITHUANIA ADOPTS DIESELS

A number of lightweight railcars are now operating in local passenger traffic

YET another European convert to the trial of diesel traction has been declared by the introduction of six railcars with electric transmission on various local services on the 5-ft. gauge lines of the Lithuanian State Railways. The duty required of these four-wheeled cars is the haulage of a 15-ton trailer up a 1 in 200 grade at 31 m.p.h., and the same load up 1 in 125 at 18·5 m.p.h. When running alone, the cars are capable of a maximum speed of 46·5 m.p.h., and 43·5 m.p.h. up a 1 in 200 grade.

The appearance and layout of these new vehicles is shown in the accompanying illustrations. Built by the Maschinen- und Waggonbau Fabriks A.G. in Simmering, the cars are powered by that company's eight-cylinder V type engine with cylinders of 5·12 in. bore by 6·3 in. stroke. The rated output is 130 b.h.p. at 1,350 r.p.m., but the same engine is rated at 160 b.h.p. at 1,600 r.p.m. in the diesel cars of the Austrian Federal Railways, which vehicles were described in the *Diesel Railway Traction Supplement* for October 6, 1933. The cylinders are set at an angle of 90 deg., and in the space between the two banks are located the Bosch fuel pump and air brake compressor. The latter is not driven by the engine, but by a 3·5 h.p. electric motor, and the set is of a capacity sufficient to supply 570 litres of air per min. at a speed of 600 r.p.m.

Should the pressure in the main lubricating oil system fall below the predetermined normal figure for more than a minute, the engine is shut down by means of an electrically operated solenoid. This arrangement requires only a small amount of oil to be carried in the supply pipes, which although sufficient for starting, does not necessitate a separate piping system and hand pump for that duty. Radiators for cooling the circulating water and lubricating oil are arranged in two banks below the floor of the car, and the cooling action of the natural draught of motion is assisted by a fan driven through a long shaft from the main engine crankshaft.

Transmission

Directly but flexibly coupled to the diesel engine is a 75 kW. d.c. generator, which, together with the remainder of the transmission and control apparatus, was supplied by the Austrian Siemens-Schuckertwerke. The whole power set, comprising engine, generator, radiators, and air compressor, is mounted on a welded steel subframe mounted on the axleboxes in such a manner that the engine vibrations are not transmitted to the car body. This interesting method of suspension is clearly shown in one of the accompanying illustrations. The subframe is built up of steel plates and angles, riveted and welded, and provided with transverse and vertical stiffeners.

There is only one traction motor, of 68 kW. capacity, and the torque reaction of this is taken up on the subframe of the power equipment. The gear ratio is 5·92:1, and gives a maximum tractive effort at the rail of 3,100 lb., and 1,425 lb. at the rail on the hourly rating. The electric control is on the Gebus system with a dead-man handle, and driving operations are regulated by a single horizontal wheel located immediately in front of the driver's seat. By turning to the left or the right from the off position, forward or reverse movement is obtained, and a further slight turning of the handle starts the engine and causes it to run at idling speed. Further turning brings the engine up to full load, and one full turn of the wheel is sufficient to bring the car from full speed forward to full speed reverse. Starting is effected electrically by means of a series winding on the generator, current

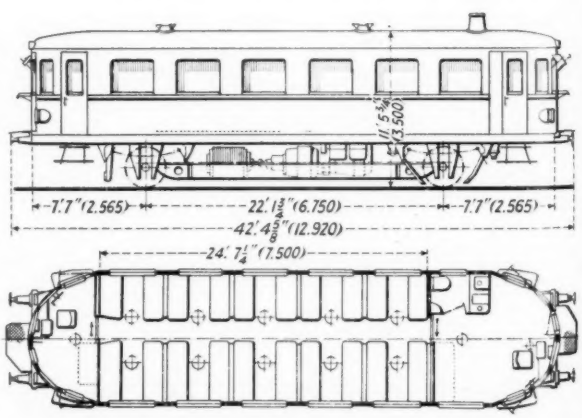


Diagram of four-wheeled diesel-electric railcar for 5-ft. gauge lines

being supplied by a storage battery situated beneath the car floor.

The cars are of light construction, with bow ends housing the driving apparatus and providing a small amount of space for parcels and luggage. End doors and a hinged platform are fitted to permit of the guard passing to the trailer. Seating accommodation for 55 third-class passengers is provided on a tare weight of 15 tons, giving a ratio of 610 lb. per seat. The seats are of the non-reversible bentwood type with grab handles of aluminium; the floor is covered with linoleum, and has trap doors for the inspection of the engine and generator.

Heating of the passenger compartment is carried out normally by circulating the engine cooling water through aluminium heaters placed beneath the seats, but in view of the severity of the winter in eastern Europe an additional heating system is embodied. This incorporates a coal-burning Narag stove located in a cupboard at one end of the vehicle and next to the lavatory. Separate heaters are provided for this system, and to heat both the car and the engine during off-duty periods the hot water from the stove is arranged to circulate through the engine cooling water circuit, and is thermostatically controlled so that the electrically driven pump is started when the temperature of the cooling water falls below a certain predetermined limit.

The four 37-in. wheels are spread over a base of 22 ft. 1 in., which is a foot longer than the Leyland railcars in Britain but 4 ft. less than the Ganz railcars in Belgium. All axleboxes are of the roller bearing type, and each wheel is braked by two blocks actuated by compressed air on the Knorr system, and by a hand brake applied by a wheel in each driving position. Air sanding gear is provided on both sides of the driving wheels, and other fittings include standard draw and buffing gear, an electrically operated window wiper, electric head and interior lights, the usual electric meters and apparatus, and a tachometer, driven from one axle.

Left: Driving position of Lithuanian diesel-electric railcar
Above: Interior of one-class railcar showing bentwood seats
Right: Heating installation for use in cold weather

Large American Diesel Cars

The Boston & Maine Railroad, which in 1928 gave proof of its interest in diesel traction by ordering a 1,450 b.h.p. diesel-mechanical locomotive (now working on the Reichsbahn) from Krupp, has recently placed orders for a number of diesel vehicles. The General Motor Corporation (Winton Engine Company division) is to build a three-car diesel-electric train of 660 b.h.p., which will make a daily mileage of over 700 in fast service between Portland, Boston, and Bangor. The bodies are to be constructed by the Edward G. Budd Manufacturing Company, and will be of stainless steel built up by the Shotweld process. The train is to have a seating capacity of 148, and will have a buffet and a luggage compartment. It is to be delivered by the end of this year.

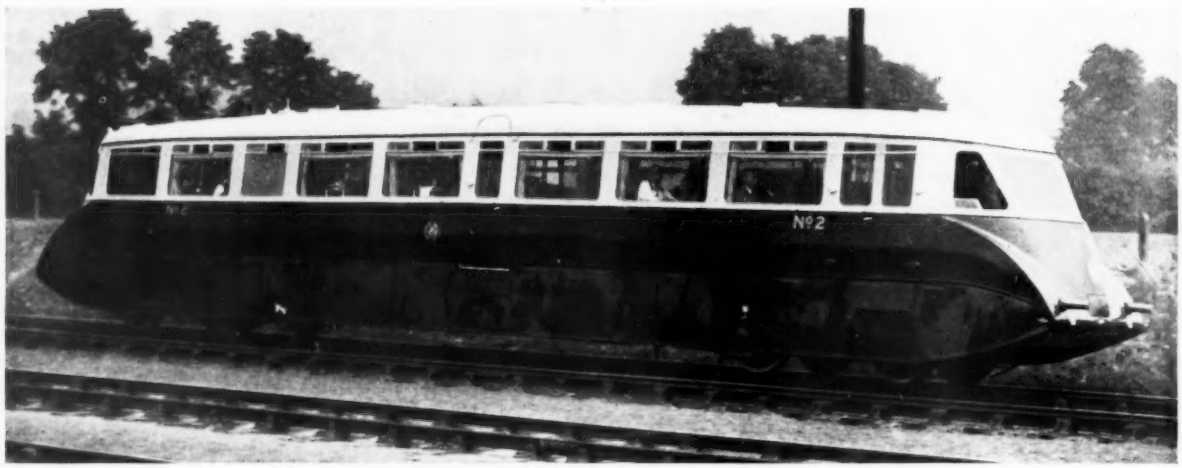
Orders have also been placed for four double-bogie diesel-electric shunting locomotives as follow: One locomotive to be built by the St. Louis Car Company, with a 600 b.h.p. Ingersoll-Rand engine and General Electric Company transmission; one locomotive to be built by the Bethlehem Steel Company with a 600 b.h.p. engine and electrical equipment by the Westinghouse Electric & Manufacturing Company; one locomotive to be built by the American Locomotive Company with a 600 b.h.p. McIntosh & Seymour "Alco" type diesel engine, and G.E.C. electrical equipment; one locomotive to be built by the G.E.C., with a 600 b.h.p. Ingersoll-Rand engine.

The Delaware, Lackawanna & Western Railroad has also placed orders for four diesel-electric locomotives, two of which will be powered by 600 b.h.p. two-stroke Winton engines, and two by four-stroke Ingersoll-Rand engines of the same power.

Seats for Railcars.—In the new diesel railcar recently constructed by the G.N.R. (Ireland) for service on the County Donegal Railways Joint Committee, and described in the *Diesel Railway Traction Supplement* for June 15 last, the seating was supplied by the Laycock Engineering Company of Sheffield, which firm also supplied the seats for the new diesel railcar of the Northern Counties Committee (L.M.S.R.) described in the same issue. So satisfactory has this seating proved that an order for another set of similar seats has recently been placed by the G.N.R. (I.).

BRITISH EXPRESS DIESEL RAILCARS

The Great Western Railway is operating three diesel-mechanical vehicles with unusual features



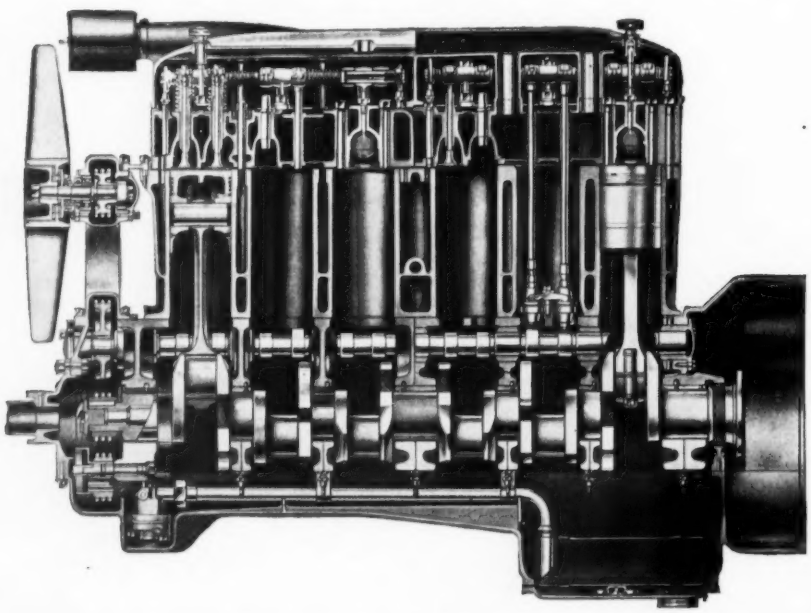
The first of the new G.W.R. diesel railcars in service

ON Monday last began the first fast long-distance regular service of diesel railcars in Great Britain—between Birmingham and Cardiff on the Great Western Railway. The vehicles for this link are the A.E.C. diesel-mechanical railcars which we illustrated and briefly described in the June 15 issue of this Supplement when recording the appearance of the new service in the public time-tables.

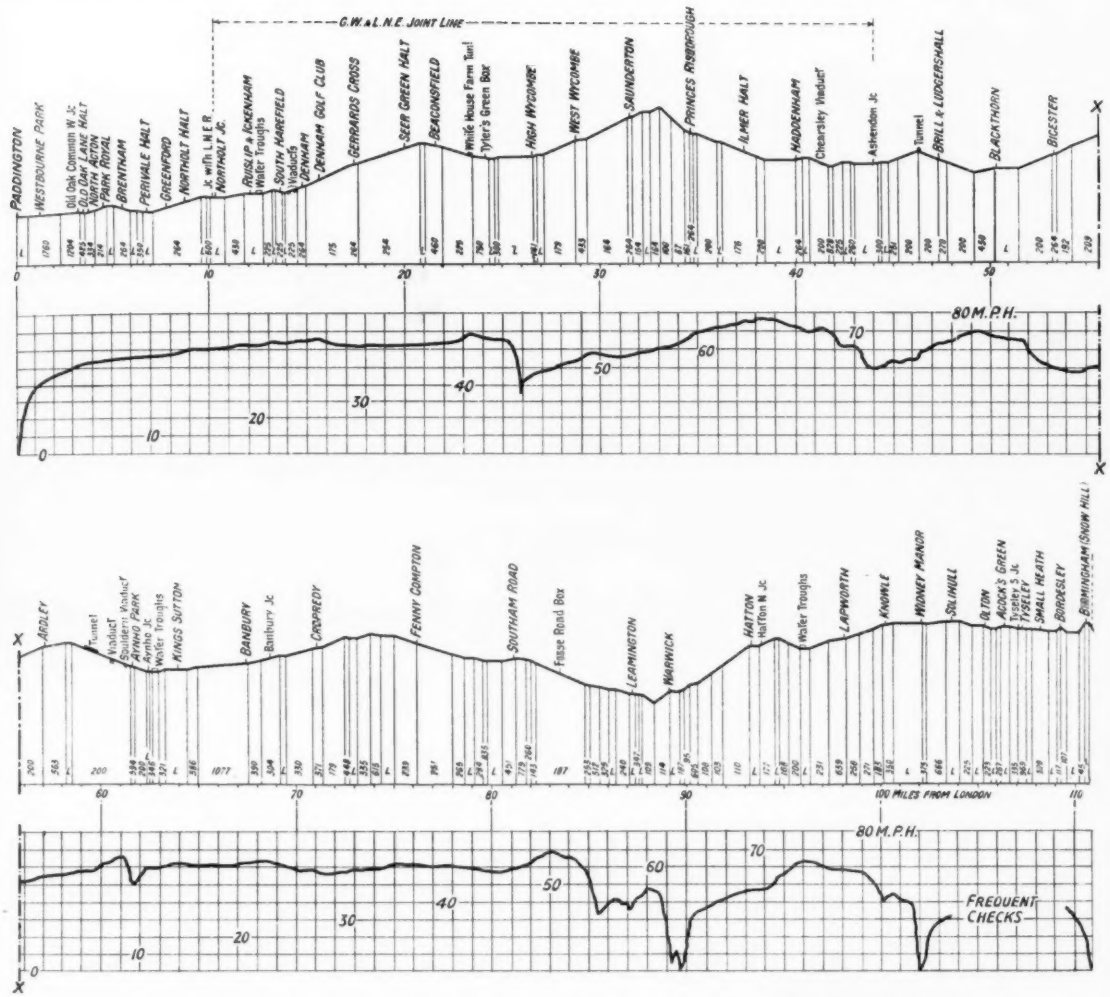
The service, which provides facilities additional to those existing, operates from Monday to Friday only on the time-tables given on the next page, in the working of which each car covers a daily mileage of 234.

Local passengers are not conveyed between Cardiff and Newport, or *vice versa*, and a supplementary fee of 2s. 6d. is charged in addition to the ordinary third class fare.

The week before going into regular operation, the first of the three cars which are maintaining the service (one is held in reserve) made some extremely interesting trial trips. On July 3, a return trip was made between Paddington and Oxford, in the course of which eight consecutive miles were covered at a speed of 70-72 m.p.h., and 44 miles were run in 40 min., or an average of 66 m.p.h. On the following day a trip was made over the much more difficult line from Paddington to Birmingham, and speeds up to 76 m.p.h. were attained. We were privileged to be on board for this trip, and obtained the speed record shown in the accompanying diagram. From Widney Manor on into Snow Hill numerous delays were encountered. On July 6, a trip was made from Birmingham to Cardiff. The party on board included the Lord Mayors of Birmingham and Cardiff, the Mayors of Gloucester and Newport, Mr. C. W. Reeve, Managing Director of A.E.C., Mr. G. E. Orton, Publicity Agent, G.W.R., and a number of press representatives. The run was made in 130½ min., with a top speed of 72·3 m.p.h., but the first 57·5 miles to



130 *b.h.p. A.E.C. engine as used in the G.W.R. cars*



Speed and gradient profiles of trial trip with G.W.R. 260 b.h.p. diesel railcar

Churchdown were covered in an hour, after which the car was eased to prevent further gain of time.

TIMETABLE OF G.W.R. RAILCAR SERVICES

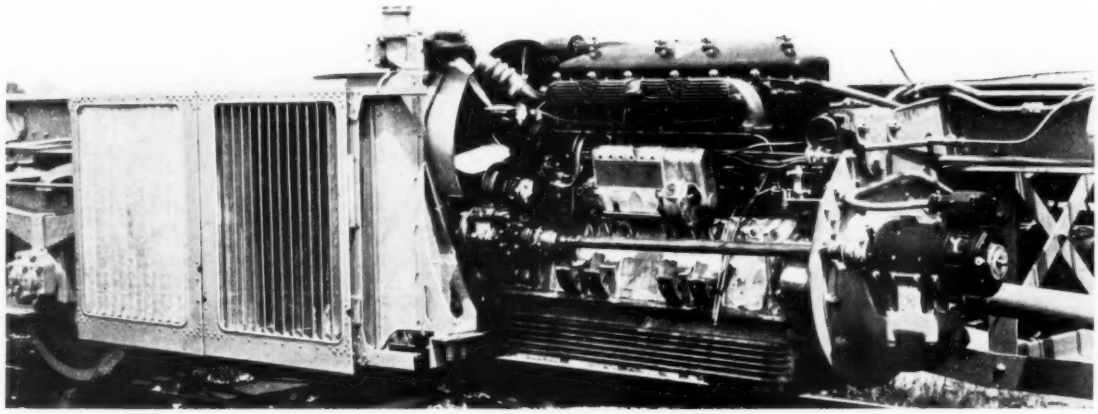
Miles.			a.m.	p.m.
—	Birmingham (Snow Hill)	dep.	9.05	3.40
60¾	Gloucester	arr.	10.17	4,52
		dep.	10.19	4,54
105	Newport	arr.	11.10	5.52
116¾	Cardiff	arr.	11.27	6.10
Miles.			a.m.	p.m.
—	Cardiff	dep.	9.10	4.50
11¾	Newport	dep.	9.29	5.06
56	Gloucester	arr.	10.21	5.55
		dep.	10.23	5.56
116¾	Birmingham (Snow Hill)	arr.	11.35	7.15

Of the six cars ordered in February last from the Associated Equipment Co. Ltd., three have now been delivered, and the chassis and power units of the remainder are complete. A final decision has not yet been made as to the service in which the last three vehicles will work, and the construction of the bodies is therefore being held over. The cars have been designed and constructed by the A.E.C., under the direction of Mr. C. F. Cleaver, to the requirements of Mr. C. B. Collett, the Chief Mechanical Engineer of the Great Western Railway. The design has been developed from that of the 130 b.h.p. which has been working since February last on the Thames Valley lines of the G.W.R., but in view of the higher speeds, two engines have been fitted instead of one.

Streamlining of the body has been carried out to a contour evolved from wind tunnel tests made at the Chiswick laboratory of the London Passenger Transport Board. These tests showed that the air resistance of the adopted form was only one-third that of a square-ended car at a speed of 50 m.p.h. Another feature of the car is the accessibility of the working parts which has been obtained without the power or transmission units encroaching upon the revenue-earning space.

Power Equipment

Two A.E.C. 130 b.h.p. diesel engines are used as the propulsive units, and they differ only slightly from the standard model as used in the London buses. The main difference is in the sump, which has been increased in capacity and provided with cooling fins, and the weight of the engine has been raised from 1,414 lb. to just under 1,500 lb. A section through the engine is given in one of the accompanying illustrations. There are six cylinders with a bore of 4·53 in. and a stroke of 5·59 in. The normal rated speed is 2,000 r.p.m., giving a piston speed of 1,865 ft. per min., and a brake m.e.p. of 95·0 lb. per sq. in., but in the present case the speed is limited to 2,400 r.p.m., which corresponds to a road speed of

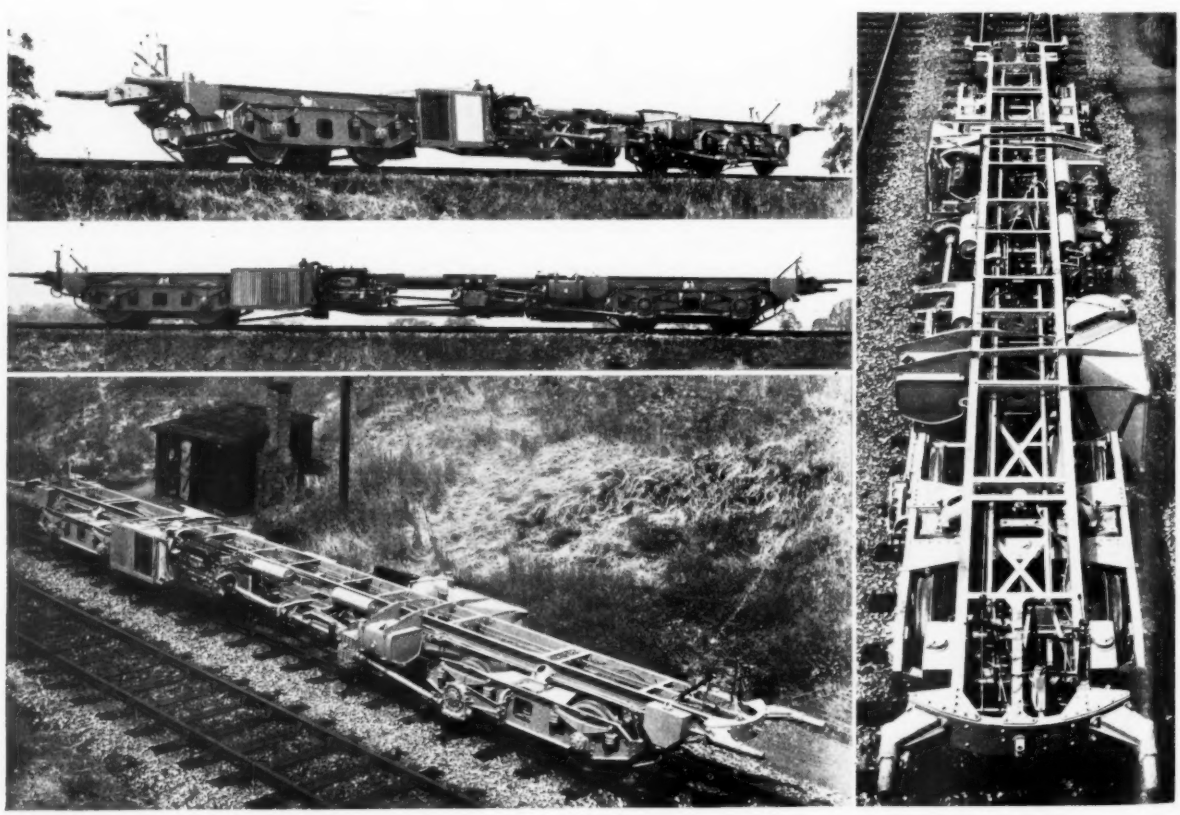


Arrangement of A.E.C. engine and radiator down the side of the car underframe

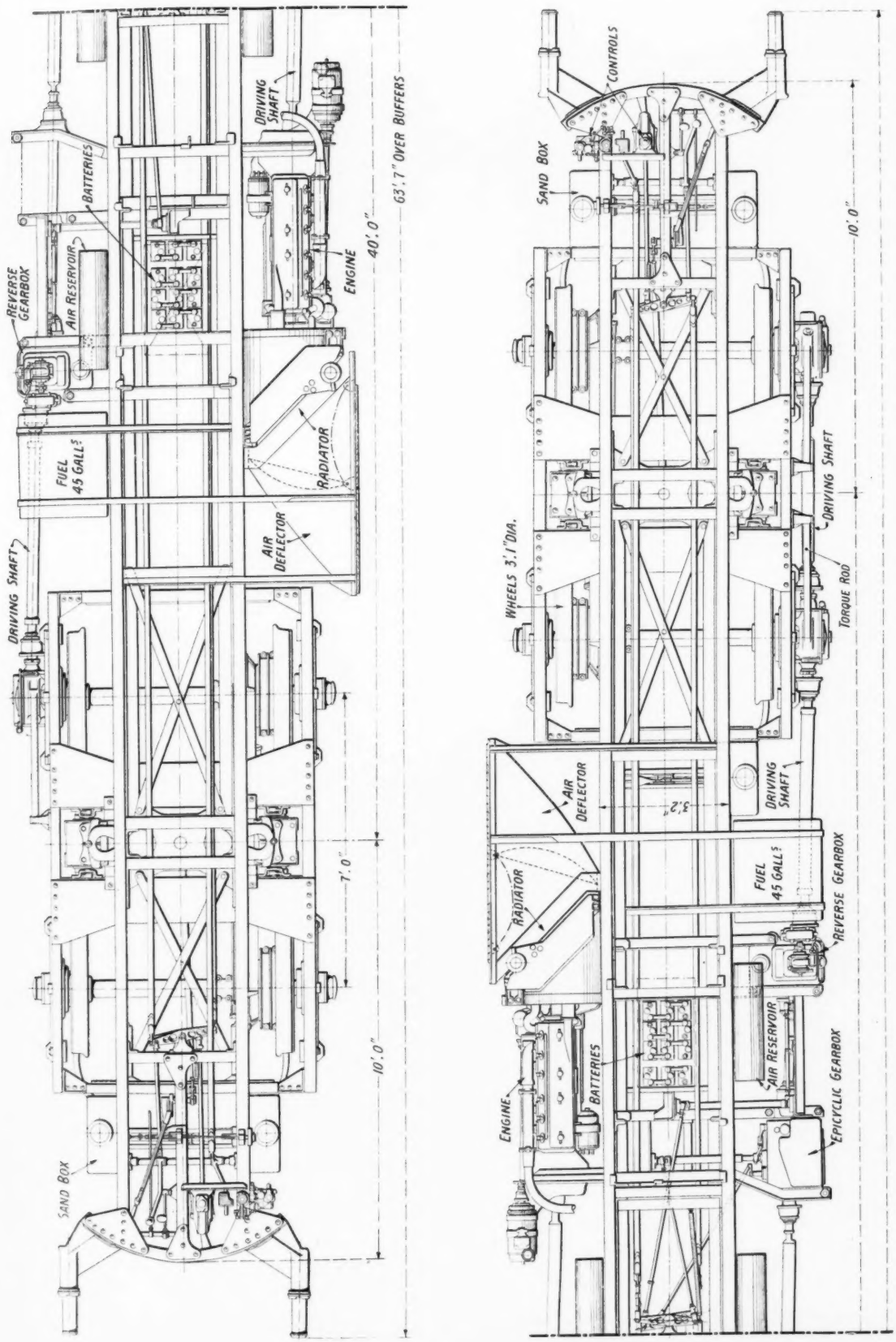
80 m.p.h. Idling takes place at 350 to 400 r.p.m. C.A.V.-Bosch fuel injection equipment is fitted, and injects the fuel into a Ricardo spherical combustion chamber, which gives a high rotational swirl to the air swept up by the rising piston. Extensive use has been made of aluminium and light alloys.

A novel method of suspension is used for the engines, one of which is located down each side of the chassis in the manner of the well-known A.E.C. "Q" type bus. The engine is hung at the rear through a Silentbloc rubber bush, and the front end foot is supported on a rubber pad, so that the engine is free to move about the line joining the bush and pad, which passes through the centre of gravity of the engine. Rotation of the engine about this line is prevented by a torque arm at the rear, which is restrained by rubber blocks.

In order to obtain the necessary frontal area for the radiator, without making it so high that it would project through the body floor, a location at 45 deg. to the longitudinal centre line of the car was necessary. An engine-driven fan is mounted between the radiator bank and the engine, and a good flow of air through the cooling elements



General views of the chassis of the new A.E.C.-engined railcars on the G.W.R.



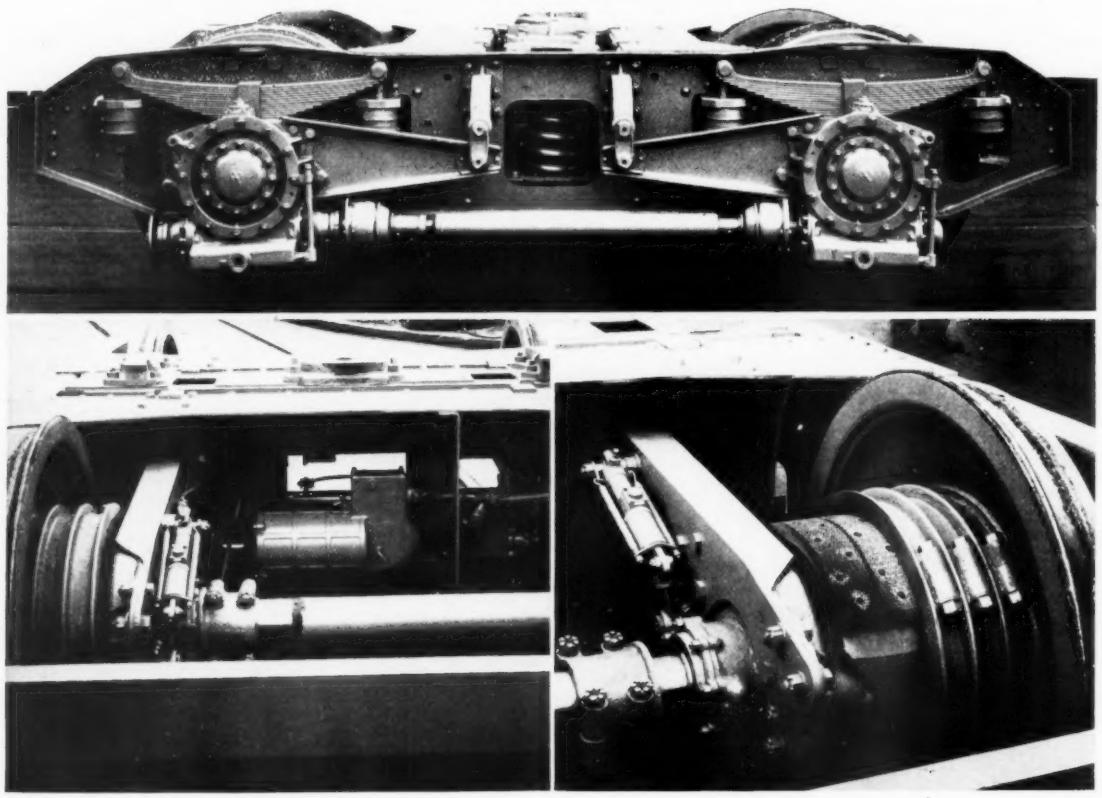
Plan of underframe and chassis of the double engine 260 b.h.p. A.E.C. express diesel railcar on the Great Western Railway. This drawing shows the layout of the direct and geared drive engines and their transmission systems, and also the interconnections between the various controls at each end of the railcar

is ensured by two means. First, the lower panels of the body which form the outside of the deflector box are fitted with two sets of louvres which point in opposite directions. Should the car be travelling with the engine leading, the air is drawn in through the louvres nearest the engine, and these are shaped in such a way as to deflect the air towards the radiator. When travelling in the opposite direction, air is taken in through another set of louvres which are straight.

Secondly, inside the aluminium deflector box is a curved flap plate hinged at the joint between the two sets of panels which takes up a position according to the direction of motion. When the engine is leading, this plate is blown back by the air pressure in such a manner as to shut off the half of the box away from the engine, and when running in the other direction it shuts off the louvres nearest the engine. The two positions of the curved deflector plate can be seen in the full-page general arrangement drawing of the chassis which accompanies this article. The relation of the deflector box and fan to the engine is well shown is the illustration on page 89, which also gives a good idea of the layout of the engine auxiliaries. The C.A.V.-Bosch fuel pump is at the mid-length of the engine, with the exhaust manifold above it, and a vacuum brake exhauster to the left. At the right, a dynamo for one of the two electric systems is mounted on bearings supported by the fluid flywheel casing. A long shaft transmits the drive from the gearing at the other end of the engine, and alongside this is situated the centrifugal water pump. Attached to the cylinder head casing at the far end is the air filter leading to the induction manifold, and above the radiator is the filling cap for the cooling water system. Between the dynamo and the underframe is the tubular driving shaft leading to the wheels.

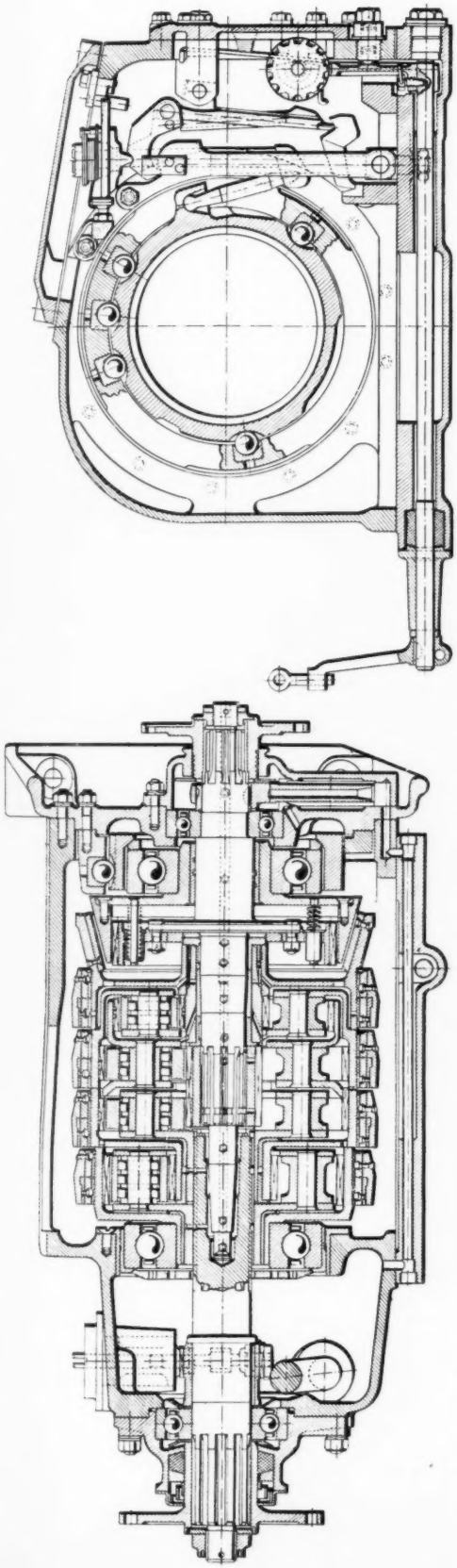
Transmission

The transmission system is probably unique among railcars of any type, in that both geared and direct drives are fitted. When it was found that the propulsion of the car at the proposed speed required two engines, it was decided that in order to simplify the mechanism and reduce the first cost, a gearbox would be fitted to one engine only, the remaining unit driving directly.



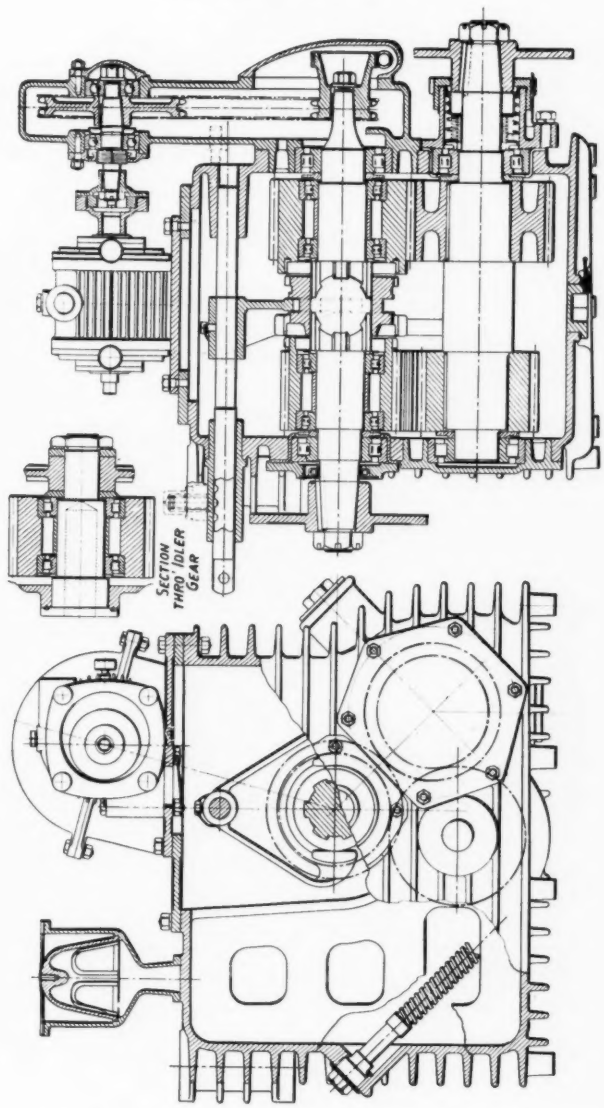
Top: Side view of driving bogie, showing driving and torque rods, G.W.R. railcar
Bottom (left): Vacuum-operated Lockheed brake in position on bogie
(right): Ferodo-brake linings withdrawn from drum for examination

This at once gave rise to several interesting problems. In the first place, as the two engines would be working at the same time, although driving separate bogies, it was necessary that the speed of the driving shafts should be the same. This would not be possible if it were not for the slip in the fluid flywheel, but to reduce the amount of slippage, and thus the heating of the oil, a device is incorporated in the throttle connection between the two engines so that the direct drive machine is given a full throttle only when in top gear, the opening at starting being approximately one-quarter. A small length of roller chain is interposed in the throttle rod connecting the two engines, and a cam-operated device connected with the change-speed gear allows slack in this chain in all gear positions except top, when the chain is taut. When in an



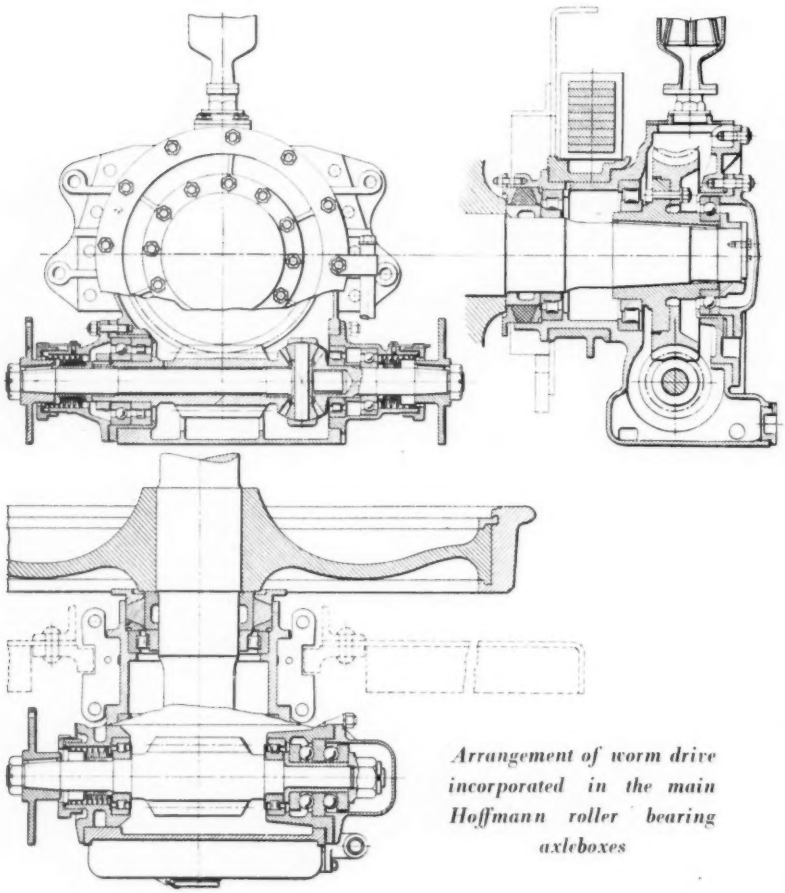
Four-speed Wilson patent epicyclic gearbox as fitted to one of the two 130 b.h.p. A.E.C. diesel engines driving the new railcars on the Great Western Railway

Reverse gearbox as used on the new G.W.R. railcars. One supplementary exhauster is mounted on top of the box and driven by a chain



intermediate gear the chain slack has to be taken up before the throttle of the direct drive engine opens.

Another difference in the drives resulting from the elimination of the gearbox on one side is that only one axle is driven by the direct coupled engine against the two driven by the geared unit, as the reduced torque is taken up adequately by the adhesion of one pair of wheels. The main transmission members on each side can be easily picked out on the chassis arrangement drawing. On the geared side they comprise, reading from the engine, a fluid flywheel, a driving shaft with flexible couplings, a four-speed Wilson epicyclic gearbox, a short driving shaft with flexible couplings, a reverse gearbox, another driving shaft leading to a worm drive incorporated in the roller bearing axlebox, a coupling shaft leading to the second axle of the bogie, and, finally, two torque rods. On the direct



Arrangement of worm drive incorporated in the main Hoffmann roller bearing axleboxes

drive side, the epicyclic gearbox and coupling shaft are eliminated, and there is only one torque rod; the place of the epicyclic gearbox is taken by an intermediate bearing between the first and second driving shafts.

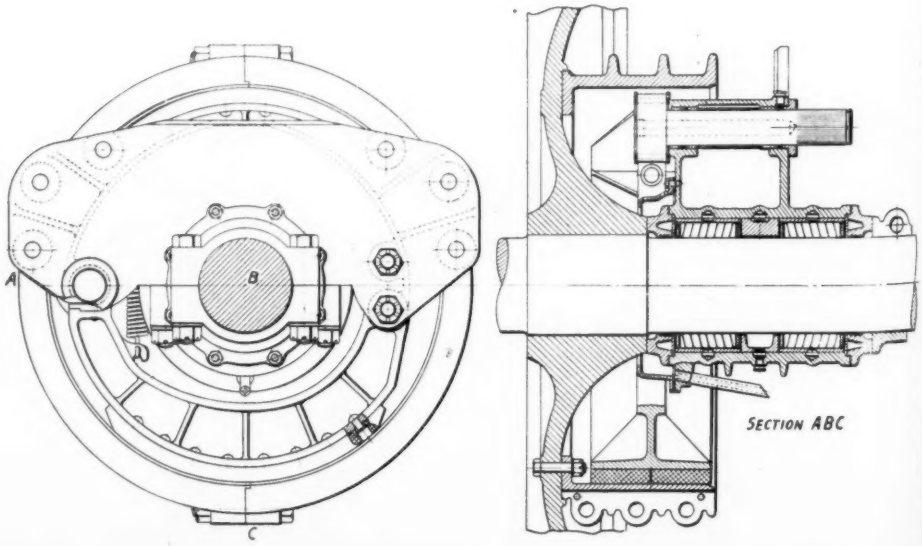
The epicyclic gearbox has wide teeth of the constant-mesh type, and planet wheels mounted on double-row roller bearings. The ratios of the four speeds are 4·5, 2·53, 1·64, and 1·0 to 1, but the worm drive on the axle is 3·12 to 1, giving a maximum normal wheel speed of 720 r.p.m. The road speeds are 18, 32, 50 and 75 m.p.h., with the engine running at 2,250 r.p.m. Fabric-lined brake bands encircling large diameter drums actuate the first, second, and third gears, and the top gear is controlled through a cone clutch. The whole actuating mechanism is adjusted automatically, and the gear is enclosed in a casing having a large oil capacity. A section through the gearbox is given in an appended illustration.

To give an equal number of speeds in both directions the drive passes through the reverse gearbox. The two shafts in this box are parallel, the driven member being the lower and farther away from the underframe, thus enabling the drive to be lined up between the engine and the axle. The aluminium box has a large oil capacity, and as a further cooling medium, ribs are cast on the outside.

The final worm drive on the axles is housed in the roller bearing axleboxes which also carry the weight of the vehicle. As may be seen from the three views of the axlebox reproduced, the worm drive is of the underslung type; the steel worm is carried in bearings in the axlebox casing, and the phosphor bronze worm wheel is bolted and splined to a flange carried on the axle. On the gear-driven side of the vehicle came another problem in the train of the novel system of drive, viz., the possibility of the wheels on the two driven axles being of slightly different diameters. To prevent the resulting excessive stress on the driving gear, a small differential is incorporated in the leading worm drive, and its construction may be seen from the drawings.

Channel section arms rigidly bolted to the axleboxes and connected to the bogie frames by shackles and Silentbloc bushes take up the torque reaction, and to ensure that the force is taken squarely on the axlebox guides, these details themselves are in the form of a separate sleeve in

General arrangement of brake drums in relation to the wheel and axle assembly, A.E.C. railcars, on the Great Western Railway. Further illustrations of the brake system will be found on page 90



which the axlebox is free to rotate within the restraining limit of the torque arm.

Underframe and Bogies

Compared with normal carriage construction the underframe is unusual in that only two main longitudinals are used. The transverse spacing over the outside of these members has been restricted to 3 ft. 2 in. in order that the complete power plant could be mounted on the outside without encroaching upon the loading gauge, and without any detail being hidden by the frame structure. This spacing also permits the mounting inside the body of any steps down to rail level which might be required. The main longitudinals are 10 in. by $3\frac{1}{2}$ in. channel sections, trussed with 4 in. by 4 in. angles, and fitted with cantilever brackets for carrying the driving gear.

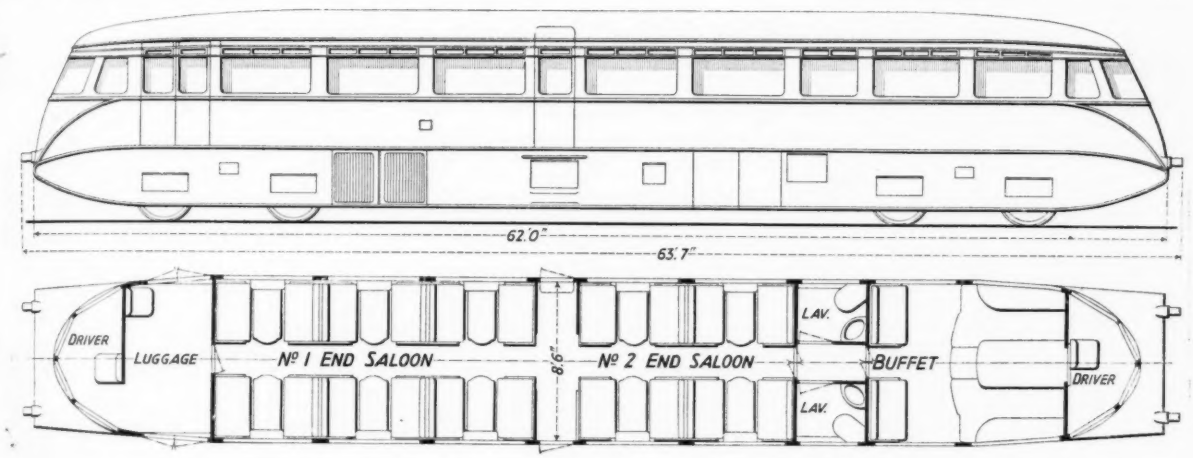
Swing-link bogies of a type which does not differ greatly from normal practice are used, and are fitted with 3 ft. 1 in. wheels spread over a base of 7 ft. The bolsters are supported by helical springs and the weight of the body and underframe is taken through the pivot and two side bearers secured to the underframe longitudinals and bearing on the bolster. The side frames and cross members are of pressed steel riveted together. Roller bearings are fitted to all axleboxes, those of the driving boxes being of the Hoffmann type and those incorporated in the carrying boxes, Timken.

Brakes

Automobile practice has been followed in getting out the principle and design of the braking system, which is of the vacuum-hydraulic type. On each bogie is mounted a vacuum cylinder connected to the master cylinder of a Lockheed hydraulic brake, and as the operating cylinders of this system are mounted directly on the torque arms, all the reactions are self-contained, and there is no relative displacement due to axle movement. The layout of this apparatus may be seen in the two illustrations on page 86. In the centre foreground of the left-hand view is the vacuum cylinder operating the hydraulic master cylinder situated on the right-hand side of the vertical gusset. The master cylinder in connected by two flexible pipes to the operating cylinder mounted on the torque arm at the left-hand side, and to the immediate right of this is the split collar holding the brake carrier in position.

Cast steel drums of 20 in. internal diameter are bolted to the inside of one wheel on each axle; the drums are split, bolted together in halves, and registered into the wheels, so that they can be removed for trueing up or replacement without disturbing the wheels. The shoes are of the internal expanding type with Ferodo liners 5 in. wide and 0·75 in. thick, and along with their operating cams and pivot pins, are mounted in a carrier supported on the axle by roller bearings and prevented from turning by a torque rod. The carrier is held endwise by the split collar, and by slacking this off, detaching one end of the torque arm and disconnecting the brake rod, it may be withdrawn complete with shoes from the drum. It is seen in this position in the right-hand view of the illustration on page 90.

Three exhausters are used to produce the necessary vacuum. Two are mounted directly one on each engine, and the third, which ensures a continuous vacuum during



Layout of new 260 b.h.p. A.E.C. diesel-mechanical railcar for the Great Western Railway

coasting periods when the engines are not running, is mounted on top of one of the reverse gearboxes and driven by a chain from the final driving shaft. Four cylindrical reservoirs are secured to the underframe, and as far as possible the pipes between the exhausters, reservoirs, and valves have been arranged down one side of the underframe and the delivery pipes from the valves to the cylinders down the other. The usual gauges are provided in both driving compartments.

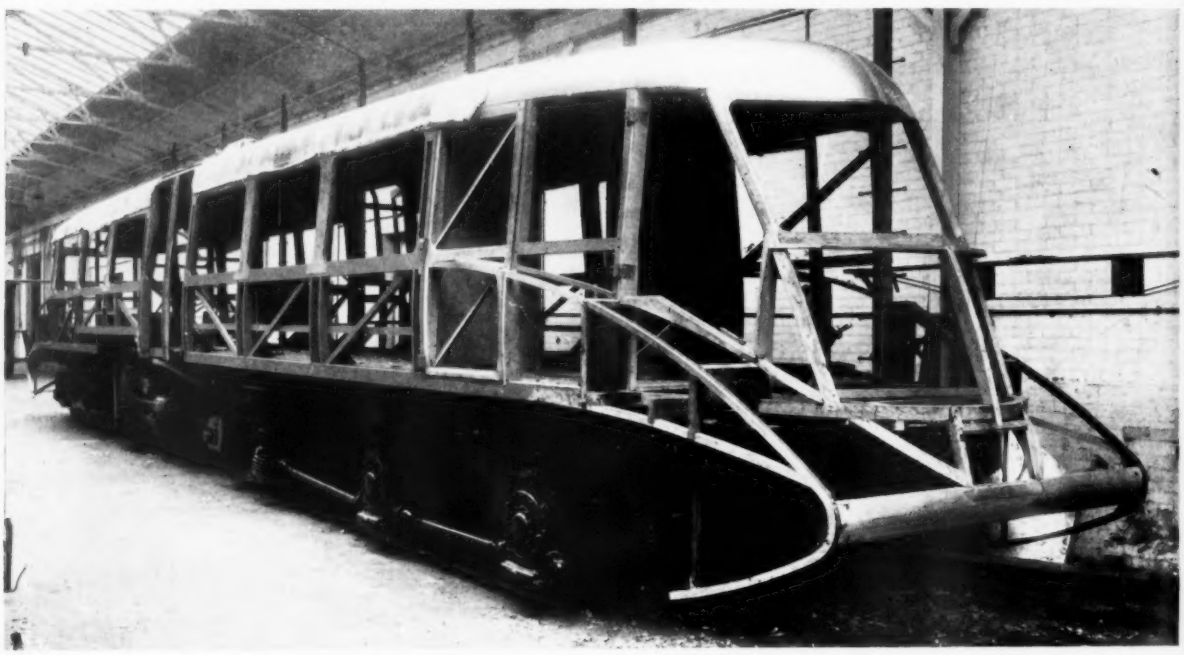
Controls

A full set of controls is mounted in each driving position, and all the movements are symmetrical. For preselecting the gear, a centre lever working in a gate is fitted. By removing the hand lever from one end of the coach to the other the gate is rendered inoperative, and does not interfere with the driver's movements at the other end. For obtaining a push and pull connection to the gearbox, three horizontal levers are mounted on cross members, and the ends connected by steel ribbons, as shown in the general arrangement drawing. Whatever the direction of the end lever, one of these ribbons is in tension, and thus moves the centre lever.

Reversing is effected by a hand lever in each cab, the centre of the above three balance levers being connected by rods and cross shafts to the reverse boxes. The driver's hand lever is moved in the direction of travel. The speed of the engine is controlled by an accelerator pedal, which is connected by light rods and bell cranks to the fuel pump. The engine stop apparatus is applied only to the engine which drives through the epicyclic gearbox, so

that when the driver's foot is taken off the accelerator pedal the gear-drive engine comes down to idling speed and the direct-drive engine to the stop position. Actually, in such position, the road wheels drive the direct engine until the vehicle stops. In practice the car starts moving with one engine.

A series of coloured lights is mounted on the dashboard, and includes a green light to each engine to show whether it is running, and a blue light for the water level in the radiator. The starter and heater switches for the two engines, the speedometer, and vacuum gauges are also mounted on the dashboard, and the vacuum sanding lever is close to the driver's hand. An emergency control gear is fitted, to enable the car to be stopped from the passenger compartment. Two separate electric systems are incorporated, each receiving its current from a 24-volt 800-watt dynamo driven by the oil engines. Two Exide batteries of 130 amp. hr. capacity are carried below the underframe.



One of the new Great Western railcars under construction at the Park Royal Coachworks

Body

The car bodies have been built by Park Royal Coachworks Limited, and the interior decoration is by Heal & Son. All the body panelling is in aluminium sheets supplied by the British Aluminium Co. Ltd., and the side panels have been brought down in the form of a valence to within 10 in. of the rail level, thus covering the driving units and providing a smooth exterior. Inspection covers are fitted opposite the various units; they are unlocked with a standard carriage key, and are easily taken down. The whole of the panelling is in commercially pure aluminium, the side valences and lower panels being 18 w.g. thick and the upper panels 14 w.g. All external woodwork not covered by panelling is sheathed in 20 w.g. aluminium, and the roof sides and ends are beaten from 18 w.g. aluminium sheet. The streamlined nose and cowling of the car ends form a good example of aluminium sheet work, for several complicated curves are involved, and the covering is made up of a number of sheets beaten and welded together. The end pieces of the roof are made of aluminium, beaten to the required profile.

Third-class accommodation only is provided, and the seating is arranged as shown on the diagram accompanying this article. The two passengers' saloons are divided by the gangway connecting the two central doors, and are fitted with 40 fixed seats with removable tables. The seats are upholstered in light green horsehair, and the tables are in oak, with a top of gold-brown Rexine to match the same material lining the interior. The panels, pelmets, and woodwork generally are in weathered oak. Green linoleum covers the floor with the addition of a heavy brown carpet covering the gangway, cross-gangway, and buffet floor.

Special attention has been paid to the lighting to give a soft diffused effect. Tubular lights with two bulbs are fitted on the side panels above each seat, and the same type of lamp is fitted down the centre of the roof, where it is interspersed with the Colt ventilators. Additional ventilation is provided by Beresford extractors above the windows. Electric fans are provided in the buffet compartment, and Clayton-Dewandre heaters are installed in the passenger saloons, buffet, and both driving compartments.

The passenger saloon is connected at one end with the buffet by means of a short gangway, with a lavatory on each side. In each lavatory is a water heater, which consists of the silencer surrounded by a water jacket, the engine exhaust gases passing through on their way to the exhaust pipe in the roof. The buffet is divided across its centre by a counter, with four seats facing it. There is ample room for passengers to stand at the counter, and on the other side are arranged tables and cupboards for the stocking of light refreshments, and also a gas-heated toaster and boiler connected to a nickel-plated coffee and milk boiler. Crockery and cutlery are also stored in the cupboards, and the water tanks are built into the bulkhead between the lavatories and the buffet, with reserve tanks beneath the tables in the kitchen.